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Impact of age on effectiveness of online versus offline group rehabilitation in knee osteoarthritis patients: A secondary analysis

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Abstract

Background: Knee osteoarthritis (OA) is a leading cause of disability in older adults. Telerehabilitation offers an alternative to in-person physiotherapy but may vary in effectiveness across age groups. This secondary analysis explored the impact of age on outcomes following online versus offline group rehabilitation in knee OA patients.

Methods: A secondary analysis of a randomized controlled trial was conducted, involving 160 participants (30–75 years) with Kellgren and Lawrence grade I–III knee OA. Participants were randomized into online (n = 76) and offline (n = 84) group rehabilitation programs, stratified into three age groups (30–45, 46–60, and 61–75 years). The intervention consisted of thrice-weekly lower-limb strengthening exercises over 6 weeks. Pain visual analog scale (VAS) and physical function Western Ontario and McMaster Universities OA index (WOMAC) were assessed at baseline, 3 weeks, and 6 weeks. Statistical analysis involved repeated-measures analysis of variance and subgroup comparisons.

Results: Participants aged 30–45 years exhibited greater improvement with online rehabilitation compared to offline (VAS reduction: 5.6 vs. 4.9, P = 0.032; WOMAC reduction: 46.3 vs. 41.2, P = 0.041). Those aged 61–75 years benefited more from offline sessions (VAS reduction: 6.3 vs. 4.8, P = 0.018; WOMAC reduction: 48.7 vs. 39.5, P = 0.024). No significant difference was found in the 46–60-year age group. Moderate effect sizes were observed for both outcomes (Cohen's d = 0.54–0.61).

Conclusion: Age significantly influences the effectiveness of online versus offline group rehabilitation for knee OA. Tailoring rehabilitation modes according to age may optimize pain relief and functional improvement.

Keywords: Age, function, knee osteoarthritis, Offline Group exercise, online rehabilitation, pain, telerehabilitation.

Introduction

Knee osteoarthritis (OA) is a prevalent degenerative joint disease and a leading cause of pain and disability in older adults.[1] It is characterized by progressive cartilage loss and joint dysfunction, resulting in chronic pain, stiffness, and reduced mobility that can severely diminish quality of life. Effective management of knee OA often relies on physiotherapy-based rehabilitation, especially structured exercise programs, to alleviate symptoms and improve function.

In recent years, healthcare has increasingly embraced digital solutions to improve the accessibility of rehabilitation services.[2]

Telerehabilitation – the delivery of rehabilitation via telecommunication technologies – has emerged as a promising approach to extend physiotherapy beyond traditional clinic settings.[2] This mode of care can help overcome barriers such as geographical distance, transportation difficulties, and scheduling constraints, allowing patients to participate in therapy from home. The COVID-19 pandemic further accelerated the adoption of telerehabilitation, underscoring its value in maintaining continuity of care when in-person visits are limited. Early evidence in musculoskeletal conditions, including knee OA, suggests that guided exercise programs delivered online can achieve pain reduction and functional gains comparable to conventional in-person rehabilitation.[3]

However, the uptake and effectiveness of technology-based rehabilitation may not be uniform across all age groups. Older adults, who constitute a large proportion of knee OA patients, often face challenges with digital health interventions due to limited experience with smartphones, computers, and telehealth applications.[4] This lack of digital familiarity and confidence could impede their engagement and adherence to remote exercise programs, potentially reducing the benefits they derive from telerehabilitation. In contrast, younger individuals tend to be more comfortable with online technologies and may find virtual rehabilitation more convenient and acceptable. These disparities raise the possibility that patient age influences the outcomes of online versus offline rehabilitation for knee OA, with older adults perhaps responding better to traditional face-to-face formats and younger patients adapting well to virtual formats.

Despite the growing use of telerehabilitation, there is limited research examining how age affects the relative success of remote versus in-person rehabilitation. Clarifying this relationship is important for tailoring treatment strategies: If certain age groups respond differently to online therapy, clinicians could customize rehabilitation delivery to ensure each patient receives the format that maximizes their recovery. To address this gap, the present secondary analysis was conducted to compare the effectiveness of online and offline group exercise rehabilitation in individuals with knee OA across different age brackets. The objective of this study was to determine whether patient age modifies the effectiveness of a group rehabilitation program delivered online versus in-person, as measured by improvements in pain and physical function.

Methods

Study design

This study was a secondary analysis of data collected from a randomized controlled trial that compared the effectiveness of online and offline group rehabilitation in patients with knee OA. The original trial was conducted over a 6-week period at the Department of Physiotherapy, Teerthanker Mahaveer University, Moradabad, India. Ethical approval for the primary study was obtained from the Institutional Ethics Committee of Teerthanker Mahaveer University (Approval No: PM/ETHICAL/PT/2023/004).

Participants

A total of 160 participants aged 30 years and above, diagnosed with Kellgren and Lawrence Grade I–III knee OA,[1] were enrolled. Participants were randomly allocated to either the online rehabilitation group (n = 76) or the offline rehabilitation group (n = 84). Inclusion criteria were: (i) presence of moderate to severe knee pain, (ii) ability to access digital devices and internet connectivity (for the online group), and (iii) absence of recent interventions, such as knee surgery or intra-articular corticosteroid injections in the preceding 6 months. Participants were stratified into three age groups for analysis: 30–45 years, 46–60 years, and 61–75 years.

Intervention

Both groups received an identical, standardized group exercise program conducted thrice weekly for 6 weeks. Each session lasted approximately 45–

60 min and was supervised by a physiotherapist. The exercise protocol included static and dynamic exercises targeting the quadriceps, hamstrings, and hip abductors, along with breathing exercises focusing on deep slow breathing techniques.[5] Exercise intensity was progressively increased from weeks 3 to 6 based on 1-repetition maximum guidelines provided by the American College of Sports Medicine.[6]

- Online group: Sessions were delivered live through the Zoom platform, ensuring real-time therapist supervision and interaction
- Offline group: Sessions were conducted in person at the physiotherapy outpatient department of the hospital
- Attendance was monitored for all participants, and exercise adherence was encouraged through regular reminders.

Outcome measures

Primary outcome measures included

- Pain intensity was assessed using the Visual Analog Scale (VAS) ranging from 0 (no pain) to 10 (worst imaginable pain).
- Physical function was assessed using the Western Ontario and McMaster Universities OA index (WOMAC) function subscale, scored from 0 (no disability) to 68 (maximum disability), and subsequently normalized to a 0–100 scale (where higher scores indicate greater functional impairment).[7]
- Assessments were conducted at 3 time points: Baseline (week 0), mid-intervention (week 3), and post-intervention (week 6).

Statistical analysis

Data were analyzed using STATA software (version 16). Descriptive statistics were calculated for demographic and baseline clinical variables. Repeated-measures analysis of variance was employed to examine changes over time within and between groups. Subgroup analyses compared outcomes between the online and offline groups within each age category. Effect sizes (Cohen's *d*) were calculated to determine the magnitude of differences. A significance level of $P < 0.05$ was considered statistically significant.

Results

Baseline characteristics

At baseline, there were no statistically significant differences between the online and offline groups across the three age categories (30–45 years, 46–60 years, and 61–75 years) in terms of pain scores (VAS) or functional scores (WOMAC) ($P > 0.05$).

Pain outcomes (VAS)

Among participants aged 30–45 years, the online rehabilitation group demonstrated a significantly greater reduction in VAS scores compared to the offline group after 6 weeks (mean reduction: 5.6 vs. 4.9 points; $P = 0.032$).

In the 61–75-year age group, participants in the offline rehabilitation group showed significantly greater improvement in VAS scores than those in the online group (mean reduction: 6.3 vs. 4.8 points; $P = 0.018$).

No statistically significant difference in VAS score improvement was observed between the online and offline groups in the 46–60-year age group ($P = 0.61$).

Functional outcomes (WOMAC)

A similar pattern was observed in functional outcomes. In the 30–45-year group, participants in the online rehabilitation arm exhibited significantly greater improvement in WOMAC scores compared to those in the offline group (mean reduction: 46.3 vs. 41.2 points; $P = 0.041$).

Conversely, in the 61–75-year group, the offline rehabilitation group demonstrated a greater reduction in WOMAC scores compared to the online group (mean reduction: 48.7 vs. 39.5 points; $P = 0.024$).

In the 46–60-year age group, no significant difference in WOMAC score improvements was observed between the online and offline groups ($P = 0.55$).

Table 1 presents the mean reductions in VAS and WOMAC scores after 6 weeks of online and offline rehabilitation, stratified by age group. Younger participants (30–45 years) demonstrated greater improvements with online rehabilitation, while older participants (61–75 years) showed greater improvement with offline rehabilitation. In the 46–60-year group, no statistically significant differences were observed between the two rehabilitation modes.

Figure 1 the bar graph illustrates the mean reduction in pain scores (VAS) and functional disability scores (WOMAC) after 6 weeks of rehabilitation among online and offline groups across different age categories (30–45, 46–60, and 61–75 years). Online rehabilitation showed greater improvements in younger participants (30–45 years), while offline rehabilitation demonstrated greater effectiveness in older participants (61–75 years). No major difference was observed in the middle-aged group (46–60 years).

Effect sizes

Moderate effect sizes were observed for both pain and function outcomes in favor of age-tailored intervention strategies. For VAS score improvements, Cohen's *d* was 0.54; for WOMAC score improvements, Cohen's *d* was 0.61.

Discussion

This secondary analysis explored whether patient age modifies the effectiveness of online versus offline group rehabilitation in individuals with knee OA. The findings revealed that younger participants (30–45 years) experienced greater reductions in pain and functional disability following online rehabilitation, whereas older participants (61–75 years) achieved superior outcomes with offline, in-person rehabilitation. Middle-aged participants (46–60 years) demonstrated comparable improvements across both modalities. These results suggest that patient age is an important factor influencing response to different rehabilitation delivery modes.

The better outcomes observed among younger individuals undergoing online rehabilitation may be attributed to higher levels of digital literacy, technological familiarity, and comfort with virtual communication tools. Younger adults are generally more accustomed to using smartphones, computers, and video conferencing platforms, which could facilitate greater engagement and adherence to remote exercise programs. In contrast, older adults often face challenges related to limited digital proficiency and confidence with technology, potentially hindering their ability to fully benefit from online interventions.[8] The preference for offline rehabilitation among older participants aligns with previous research highlighting digital inequality among older adults and their preference for face-to-face interactions to receive health services.[4]

Table 1: Comparison of pain (VAS) and functional (WOMAC) score reductions after 6 weeks across age Groups and rehabilitation modes

Age group	Outcome	Online group (mean reduction)	Offline group (mean reduction)	*P*-value
30–45 years	VAS	5.6	4.9	0.032
30–45 years	WOMAC	46.3	41.2	0.041
46–60 years	VAS	5.1	5.0	0.61
46–60 years	WOMAC	44.0	43.5	0.55
61–75 years	VAS	4.8	6.3	0.018
61–75 years	WOMAC	39.5	48.7	0.024

VAS: Visual analog scale (0=no pain, 10=worst pain); WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index (higher scores indicate worse function). A $P < 0.05$ was considered statistically significant

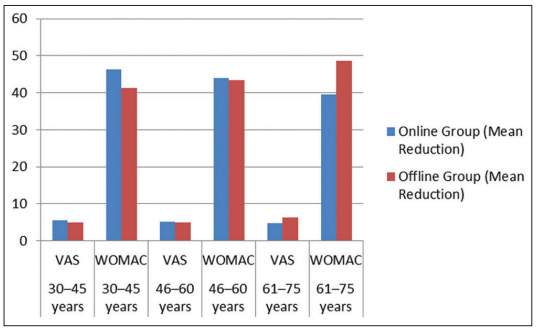

Figure 1: Comparison of pain (visual analogue scale) and function (Western Ontario and Mcmaster Universities Osteoarthritis Index) score reductions between online and offline rehabilitation groups across age groups

These findings are consistent with earlier studies suggesting that telerehabilitation can produce outcomes equivalent to in-person physiotherapy in musculoskeletal conditions,[2,3] but patient-specific factors such as age, digital literacy, and personal preferences may significantly influence the effectiveness of remote care. In particular, the results echo the concerns raised by Seifert *et al*.[4] regarding barriers faced by older adults in digital health interventions. Tailoring rehabilitation delivery based on patient age and technological competence may therefore enhance clinical outcomes and patient satisfaction.

From a clinical perspective, these results have important implications for physiotherapy practice and service delivery models. Clinicians should consider integrating flexible, age-sensitive approaches when prescribing rehabilitation programs. For younger patients, online group exercise sessions may offer a convenient, accessible, and equally effective alternative to traditional care. For older patients, offering offline group rehabilitation or providing additional technological support may optimize adherence and functional recovery. Healthcare institutions may benefit from adopting hybrid models that combine online and offline options based on individual patient needs.

This study also has implications for healthcare education and policy. Physiotherapy curricula should emphasize the development of digital health competencies among future practitioners, including strategies to support older adults in virtual care environments. Policymakers may consider initiatives to enhance digital literacy among aging populations, ensuring equitable access to the benefits of telerehabilitation and other telehealth services.

Despite its strengths, including the use of a standardized intervention and a stratified age-based analysis, this study has several limitations. As a secondary analysis, the research relied on previously collected data, limiting control over original randomization and intervention implementation. The sample sizes within each age subgroup, particularly the older cohort, were modest, which may affect the generalizability of findings. In addition, variables such as educational background, socioeconomic status, and baseline digital literacy were not assessed and could have influenced the outcomes observed. These limitations should be considered when interpreting the study findings and planning future research.

Future research should focus on prospective, large-scale trials that stratify patients by age and digital competence to confirm these findings. Studies exploring long-term adherence, functional outcomes beyond 6 weeks, and patient satisfaction with different rehabilitation modes would provide valuable insights. Qualitative research examining patient experiences and preferences across age groups could further inform the design of personalized, effective rehabilitation programs in both online and offline formats.

Conclusion

This study highlights the significant role of age in influencing the effectiveness of online versus offline group rehabilitation for individuals with knee osteoarthritis. Younger patients (30–45 years) demonstrated better outcomes with online rehabilitation, likely due to higher digital familiarity and engagement, whereas older patients (61–75 years) benefited more from traditional offline interventions. Middle-aged

individuals (46–60 years) showed comparable improvements across both formats. These findings underscore the importance of adopting age-sensitive, patient-centered approaches when prescribing rehabilitation programs. Tailoring rehabilitation delivery according to patient age may optimize pain relief, functional recovery, and overall adherence in physiotherapy practice. Future research should further explore strategies to enhance digital inclusion and long-term outcomes across diverse patient populations.

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